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Preliminary Evaluation of Meteorological Data Assimilation Approaches for a Real-Time Emergency Response System

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We are currently developing data assimilation capabilities for an emergency response system, the Atmospheric Release Advisory Capability (ARAC). A variety of algorithms are needed to generate meteorological fields depending on the type of field, the availability of input data, and the different purposes for which the output fields are to be used, for example as input to drive dispersion models or for the initialization of mesoscale models. For an immediate response, computational efficiency and robustness in cases of limited observational data are critical. Further in many applications, preservation of the observational data is highly desirable. We provide split vertical-horizontal interpolation and extrapolation methods using either direct or iterative approaches to satisfy these criteria. In contrast, the initialization of mesoscale forecast models involves a blending of gridded analyses and local observations in which filtering is used to produce smooth output fields and preservation of individual observational data is not appropriate.

We have also developed a numerical model based on variational formulation to adjust the wind fields to satisfy the non-divergence constraint and to create, at the same time, a consistent vertical wind component . Specifically, our algorithm uses a finite-element spatial discretization based on a grid-point rather than a flux-based representation of the wind fields, a choice of efficient conjugate gradient solvers, the use of differential weighting for the horizontal and vertical velocity adjustments to reflect the effects of atmospheric stability, and flexible combinations of boundary conditions including the ability to preserve wind values for cells in which observations were located.

In this paper, we will compare various approaches to the generation of meteorological fields using analytic terrain and winds, tracer experiments, current data from observations and/or forecast model output with the goal of determining the best techniques for future ARAC development and applications. Our focus will be on the generation of mass-consistent wind fields, which are of primary interest to ARAC, the preservation of observational values, and the generation of the vertical wind component.

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